WIZARD LAKE

Alberta

ENVIRONMENT
Water Quality Control Branch
Pollution Control Division

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Lakes attract people. And people want to know why "their" lake is the way it is — why is it so green in July? Is the water quality really deteriorating? How do our activities affect the lake?

This brochure, one of a series on Alberta's lakes, attempts to answer these questions by presenting findings of water quality studies conducted by the Water Quality Control Branch of Alberta Environment.

As you read through the brochure, you may find you have questions about the concepts and illustrations. At the end is a section called **Explanation of Lake Characteristics.** Refer to this for further interpretation.

Brochures are available for the following lakes:

Sandy Lake	Pine Lake	Lac La Biche
Lac La Nonne	Garner Lake	Nakamun Lake
Wizard Lake	Skeleton Lake	Wabamun Lake

Wizard Lake is located about 18 km south of Calmar, Alberta. This small, attractive lake is popular with water skiers. A campground operated by the County of Leduc — Golden Jubilee Park — is situated on the north shore near the east end. There is a public boat launch at the end of the road running east of the park.

Northern Pike ("jackfish") and Yellow Perch inhabit the lake. Wizard Lake is not fished commercially.

The lake is deepest (11 m) in the center of its eastern half. (See the Depth Contour Map.) The north-west section becomes shallower proceeding toward the end, then narrows toward a plant-filled slough that is best navigated by canoe. For the purpose of this booklet, the slough is not considered a part of the lake.

Wizard Lake is long and narrow with a maximum width of only 550 m and a length of about 8 km. The outflow, called Conjuring Creek, drains toward the North Saskatchewan River.

The drainage area to lake volume ratio is fairly large for Wizard Lake. Thus, one might expect that Wizard would be quite fertile because it is surrounded by a large area of land from which it receives nutrients.

Land use in the watershed plays a major role in determining Wizard's water quality. The watershed map shows the proportion of natural vegetation areas cleared for agriculture and cottage development.

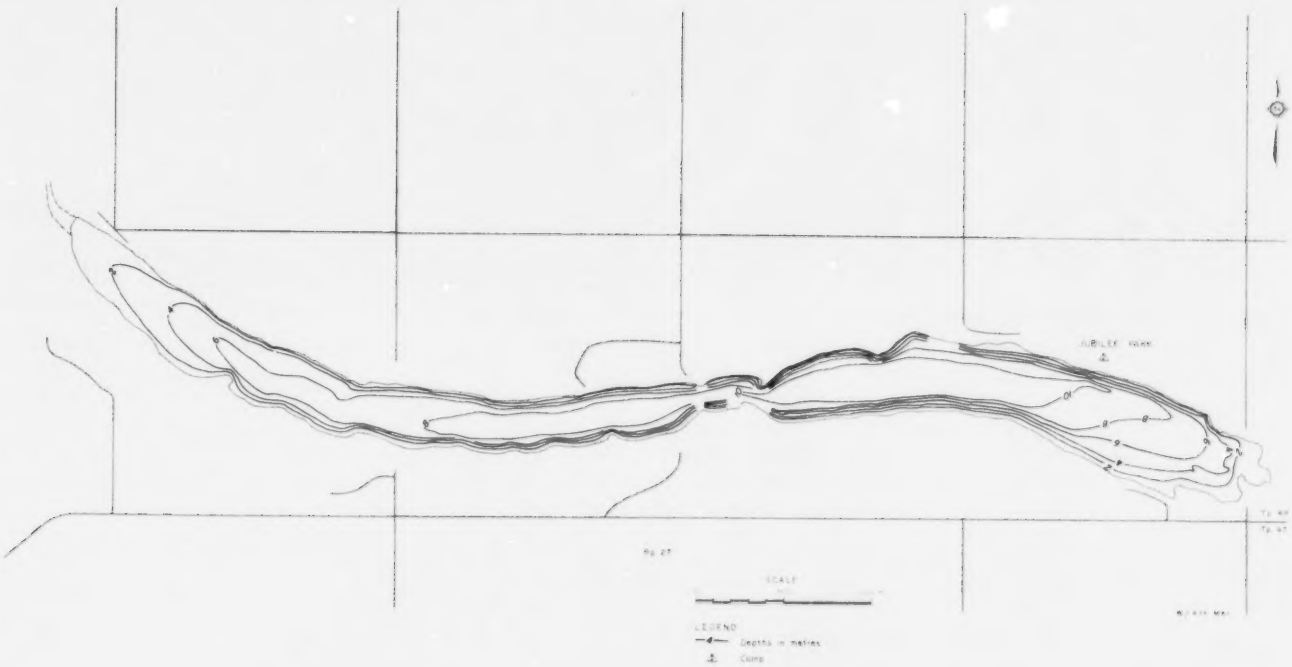
Although the area now used for agriculture is proportionally smaller than that found in natural vegetation, about 50 per cent of the phosphorus supply to the lake is derived from cleared land and cottage areas.

If all of this land (agricultural and urban) could be converted back to forest, the total phosphorus supply to the lake would be reduced (theoretically) to one-third of its present quantity.

The value for sewage input reported in the Theoretical Phosphorus Supply table is undoubtedly much higher than actually occurs in the lake because it represents the worst possible case (see Explanation, p.8). Even with sewage inputs exaggerated, agricultural activity provides the largest single supply of phosphorus.

Few people realize that a slough such as the one connected to the north end of Wizard benefits water quality in the lake. Sloughs within lake watersheds tend to act as nutrient traps, retaining a large portion of the phosphorus from the surrounding land. For example, if the land area now covered by the slough were dry, the phosphorus supply to Wizard from that part of the watershed would be more than 200 kg, rather than the 52 kg listed in the table.

Depth Contour Map



PHYSICAL AND HYDROLOGICAL CHARACTERISTICS		
LAKE AREA	km^2	2.77
DRAINAGE AREA (excluding lake)	km^2	31.82
DRAINAGE AREA/ LAKE VOLUME		2.3
VOLUME	m^3	14.1×10^6
MAXIMUM DEPTH	m	10.67
MEAN DEPTH	m	5.
INFLOW	m^3	3.11×10^6
RESIDENCE TIME	years	4.5

Wizard Lake
Watershed Map

Forest/Bush

Agricultural/Cleared

Urban/Cottage

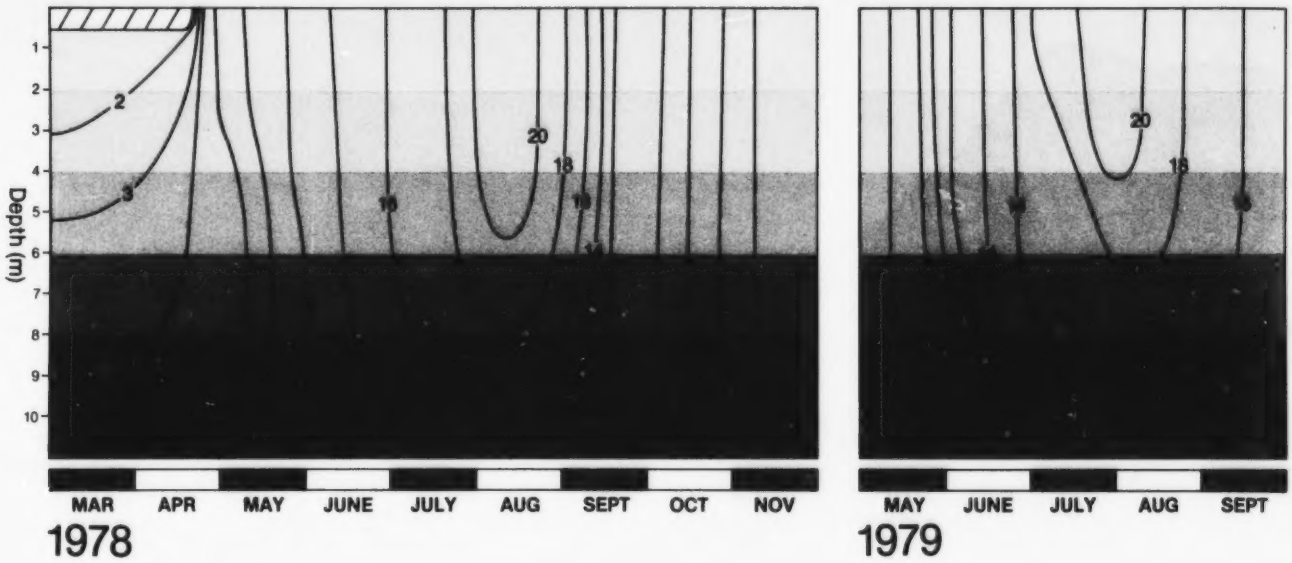
Wetland

THEORETICAL PHOSPHORUS SUPPLY, kg/year	
Surface Run-off:	
Forested/Bush	111.
Cleared/Agricultural	313.
Urban/Cottages	228.
Precipitation, Dustfall	84.
Upstream slough	52.
Sewage from all cottages and camps	286.
TOTAL	1074.
Areal loading, g/m² of lake surface	0.38

0 1 2 3

km

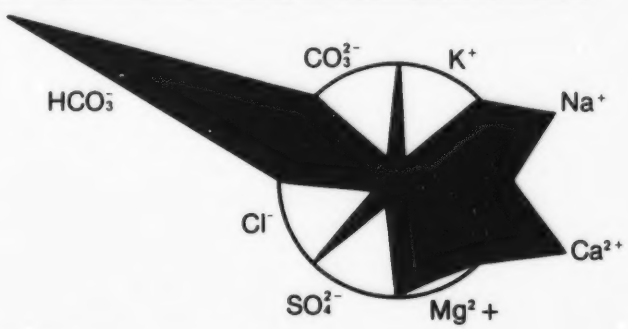
Temperature (°C)



Bicarbonate (HCO_3) ion dominates the water chemistry of Wizard Lake, with sodium (Na), and calcium (Ca) second in dominance. Total dissolved solids and salinity are quite low. The range of pH and the other chemical constituents are favorable for fish and other aquatic life.

The looped lines on the temperature graph for July and August both summers indicate layering. But because the lake is fairly shallow, this layering effect is probably weak, so that a strong wind during these months could disrupt the layers. By September, the lake was fairly well mixed.

IONIC DIAGRAM — Relative proportions of ions 1978-79

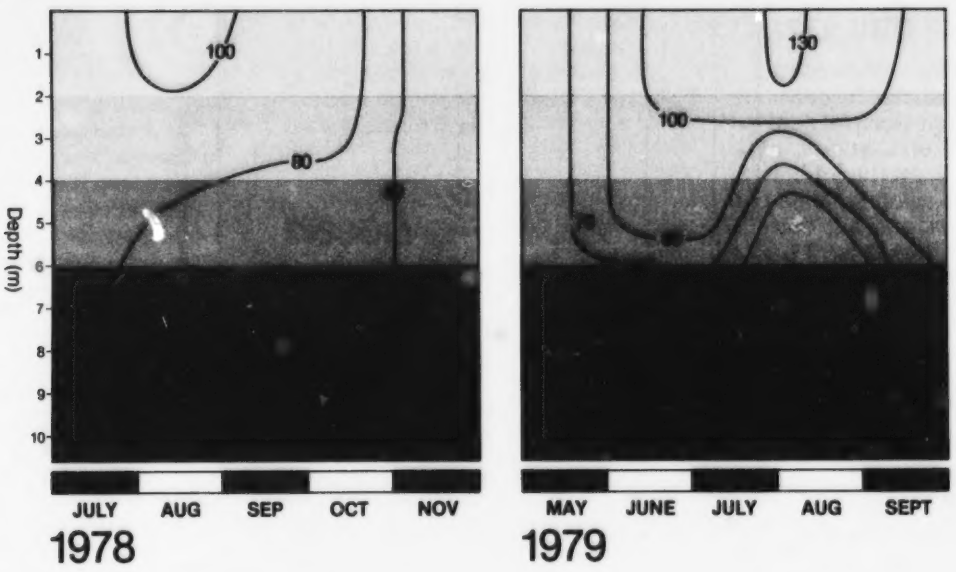


CHEMISTRY — ice-free season averages

		1978	1979
TOTAL SALINITY	meq/L	7.	7.
pH (range)		7.6 - 8.6	7.1 - 8.9
ALKALINITY	mg/L	161.	156.
TOTAL DISSOLVED SOLIDS	mg/L	180.	171.

SEE "EXPLANATION OF LAKE CHARACTERISTICS" AT END OF BROCHURE FOR CLARIFICATION OF THESE GRAPHS.

Dissolved Oxygen (% Saturation)



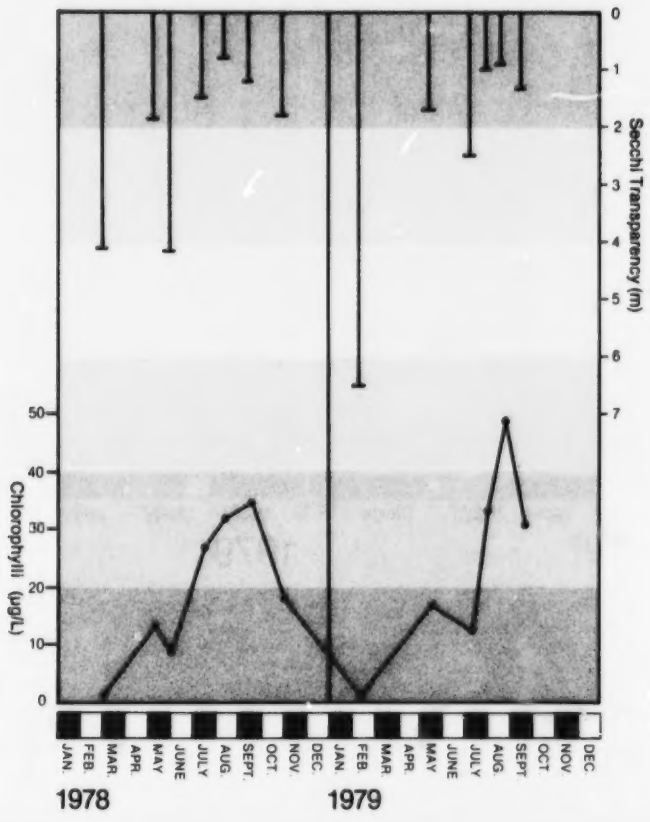
Oxygen was very low in the bottom half of the water for most of the two summers studied. During the layering period, this was very pronounced, with oxygen dropping from 80 per cent saturation to 20 per cent over a change in depth of about one metre.

In contrast, the upper layer was supersaturated (over 100 per cent) in 1979 when the amount of algae in the water was greatest. Supersaturation often occurs when large amounts of photosynthesizing algae are present.

Oxygen measurements taken in winter for both years indicated a good supply for fish, even in February and March.

Anyone who has waterskied on Wizard Lake on a hot day in early August knows that the lake is subject to blooms of blue-green algae. This type of algae is particularly troublesome because it can blow onto

Trophic Status



beaches. As it decomposes, it turns blue and produces an unpleasant odor.

Because these blooms are present and phosphorus and chlorophyll levels are relatively high, the lake can be categorized as eutrophic.

The graph above shows the changes in chlorophyll (algae) over the two summers studied. The pattern for 1978 was similar to that for 1979, with a small burst of growth in spring, a decline, and then a large population build-up in July and August. The water became green and turbid during this time. The lake was slightly more eutrophic in 1979 than 1978. However, this does not indicate that water quality is deteriorating in Wizard. All lakes vary from year to year, depending on weather cycles and many other factors.

Even though it is probable that Wizard Lake has always had an abundance of aquatic plant life, human activities in the watershed undoubtedly contribute to its eutrophic state. Most people believe that sewage is a primary cause of water quality problems in lakes. But more important is the way the land itself is managed. Removing trees, fertilizing lawns, watering cattle, — or anything that disrupts the natural vegetation — can increase the flow of nutrients to Wizard, and thereby promote the growth of algae and weeds.

TROPHIC CHARACTERISTICS — ice-free season averages

		1978	1979
PHOSPHORUS	ug/L	59.	61.
NITROGEN	mg/L	1.31	1.46
CHLOROPHYLL	ug/L	22.	29.
SECCHI TRANSPARENCY	m	1.9	1.5

Explanation of Lake Characteristics

PHYSICAL AND HYDROLOGICAL CHARACTERISTICS

Drainage Area or the watershed of a lake is the land surface from which a lake receives its water. As rain water or snowmelt gathers in streams, it picks up soil particles, nutrients and other materials and carries them to the lake.

A study of more than 30 Alberta lakes shows that when drainage areas are large compared to lake volumes, (i.e. when this **Drainage Area/Lake Volume** ratio is large), lakes have more algae (are more eutrophic) (see TROPHIC CHARACTERISTICS).

Mean Depth is the volume of the lake divided by the surface area. Shallow lakes are often more eutrophic than deeper lakes of a similar size.

Inflow is the total volume of water entering the lake in a year. It is related to **Residence Time,** which indicates the time it would take the inflow to completely fill an empty lake.

TEMPERATURE

Alberta lakes show two basic annual patterns of temperature distribution through the water.

Deep lakes, or those protected from strong winds, form layers with the coldest water near the bottom. Because this colder water is denser, it resists mixing into the warmer, lighter upper layer.

For much of the summer, the bottom portion of water is isolated from the top portion. In spring and fall, these lakes usually mix from top to bottom from wind action as the water becomes uniform in temperature and density. In winter, under ice, the warmest water (about 4°) is on the bottom, because water is most dense at this temperature.

Shallow lakes mix throughout the summer or layer only temporarily. In winter, the temperature pattern of these lakes is similar to that of deep lakes.

The diagram(s) show temperature at each depth over the annual cycle. Similar temperatures over time are connected by lines called isotherms. Vertical lines indicate mixing, while horizontal lines indicate layering.

DISSOLVED OXYGEN

Oxygen is essential to the life in lakes. It enters the lake water from the air through wind action, and plant photosynthesis.

Oxygen is consumed by respiration of animals and plants, including the decomposition of dead organisms by bacteria. A great deal can be learned about the "health" of a lake by studying its patterns and quantity of oxygen.

Lakes that are unproductive (oligotrophic) will have sufficient oxygen throughout the year at all depths. But as a lake becomes more eutrophic, and increasing quantities of plants and animals respire and decay, the balance shifts toward consumption — especially near the lake bottom where dead organisms accumulate.

In deep productive lakes (see TEMPERATURE), the oxygen in the isolated bottom layer may deplete rapidly, forcing fish to move into the upper layer (Fish are stressed when oxygen falls below about 20% saturation — shown in red on the diagram). Fish kills occur when decomposing or respiring algal populations use up the oxygen. In summer, this usually happens during an algal bloom on calm nights.

The diagram shows oxygen saturation at each depth over the annual cycle. Similar saturations over time are connected by lines called isopleths. Vertical lines indicate uniform saturation from top to bottom, while horizontal lines indicate stagnation near the bottom.

SALINITY AND TOTAL DISSOLVED SOLIDS

Lake water contains a multitude of dissolved substances. These can be seen by allowing a dish of lake water to evaporate. If the water is filtered to remove living organisms and other particles, and then allowed to evaporate, the residue is called **Total Dissolved Solids.**

The ions* that make up most of this residue can be measured individually, giving a value for **Total Salinity** when added together. The **Ionic Diagram** presents all of the major ions in a lake in proportion to each other.

Salinity is controlled by the types of rock or soil in the watershed and by the amount of evaporation relative to precipitation. Lakes of high salinity, such as many of those found in southeastern Alberta, have fewer species of plants and animals than freshwater lakes; many are too saline to support fish.

*Ions: Chemical form in water of constituents such as sodium and carbonate.

PH AND ALKALINITY

The pH of lake water refers to its concentration of hydrogen ions on a scale that runs from 0 (extremely acidic) to 14 (extremely alkaline). A pH of 7 is neutral — neither acidic nor alkaline.

Most Alberta lakes fall between pH 6 to 9, with the majority on the alkaline side. **Alkalinity** refers to the capacity of water to neutralize an acid, and is a measure of the alkaline materials present in the water.

Alberta lakes that were formed in sedimentary bedrock have a large capacity to neutralize acids entering them, such as from acid rain.

TROPHIC CHARACTERISTICS

The word "trophic" literally means nourishment.

Mountain lakes usually are "poorly nourished" or **oligotrophic.** Levels of nutrients such as phosphorus and nitrogen are low, plant life is sparse, and the water is clear. Fish production is low.

On the other end of the scale are well-nourished or fertile lakes called **eutrophic.** In these lakes, aquatic plants, including tiny suspended algae, flourish because the water contains abundant nutrients.

Mesotrophic lakes, those intermediate in fertility, often combine the best features of the other two types.

In some lakes, the nutrient supply is so high that plant growth inhibits the recreational use of the lake. Lake users consider such a lake to have poor water quality. One of the purposes in studying lakes is to determine whether fertility is increasing.

There are several ways to measure a lake's fertility or **Trophic Status.**

Phosphorus and **nitrogen** can be measured directly. Phosphorus in lakes of the Boreal Forest/ Parkland areas of Alberta range between 10 and 120 ug/L, or oligotrophic to highly eutrophic, and nitrogen ranges between 0.5 and 3.5 mg/L.

Transparency declines as a lake becomes more fertile. It is measured with a black and white plate called a **Secchi Disc,** which is lowered through the water on a line marked at metre intervals. The depth at which it can no longer be seen is the Secchi transparency.

The quantity of algae in the water can be determined by measuring its content of **Chlorophyll,** the green photosynthetic pigment.

The number of animals living in the bottom mud of the lake also may indicate its fertility. **Oligochaeta** are tiny worms; **Chironomidae** are immature stages of a fly called a midge.

THEORETICAL PHOSPHORUS SUPPLY

Lake scientists know that for most lakes, the amount of algae in the water is related directly to the amount of phosphorus. This is because phosphorus is usually in shortest supply of all the nutrients that lake plants need. When it runs out, the algal population can no longer increase. A larger phosphorus supply usually results in more algae.

Based on studies from all over North American, the quantity of phosphorus contributed by a hectare of forest is remarkably similar no matter where the lake is located. Similarly, agricultural or cleared land overlying sedimentary bedrock contributes fairly similar quantities of phosphorus per hectare in most lake watersheds. This was confirmed for Alberta by measuring quantities of phosphorus supplied by various land uses in the Baptiste Lake watershed.

In all studies, the phosphorus supply from cleared or agricultural land was greater than that from forest, averaging 5 times more.

The "theoretical" phosphorus supply is estimated, without actually measuring it, by multiplying phosphorus supply factors for each type of land use by the area of that land use.

Similar factors are used for the supply from precipitation. The supply from sewage assumes that all sewage enters the lake, since it is nearly impossible to measure this source in lakes. Therefore, the number reported represents the maximum possible supply from that source.

It might be expected that a large phosphorus supply would produce a eutrophic lake. But the size of the lake is also important. If the total phosphorus supply is divided by the surface area of the lake, the resulting **Areal Loading** figure can be compared with other lakes, and can be used as an indication of trophic status.